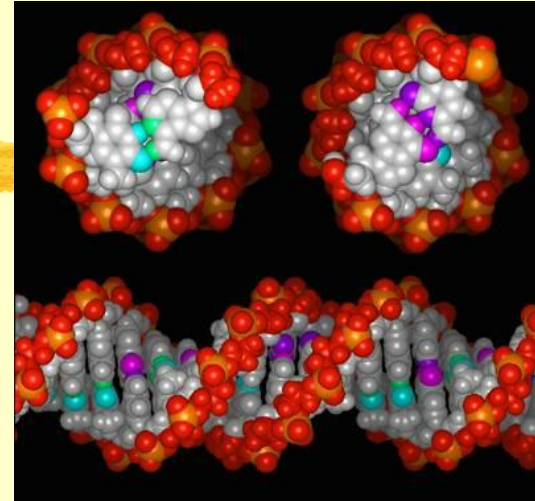
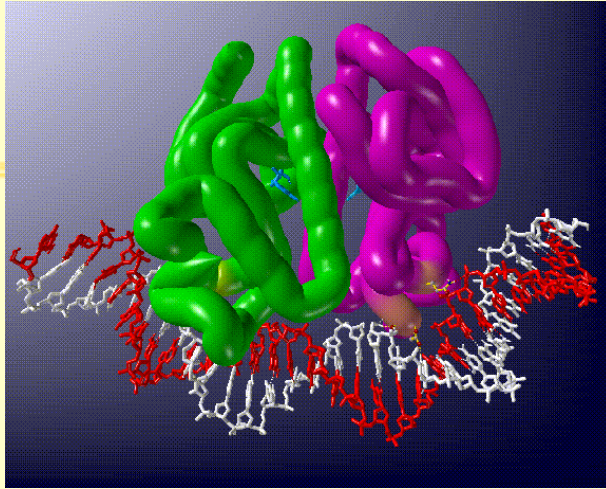


Chemical Foundation for Cells



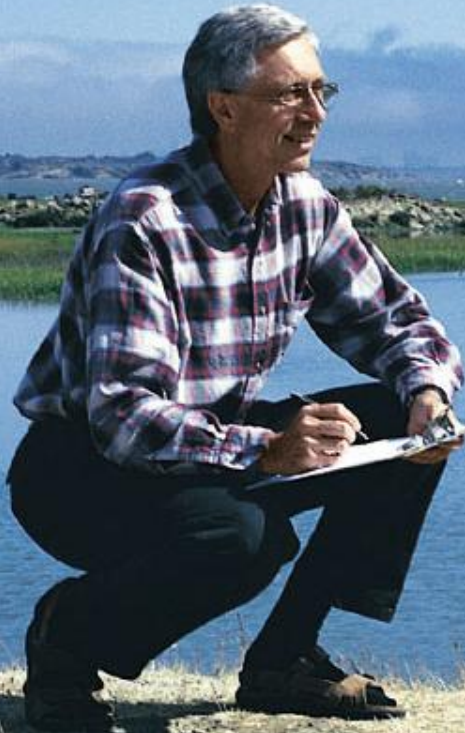
Honors Biology

Chapter 2

Revised by:
R. LeBlanc, MS
3/2011

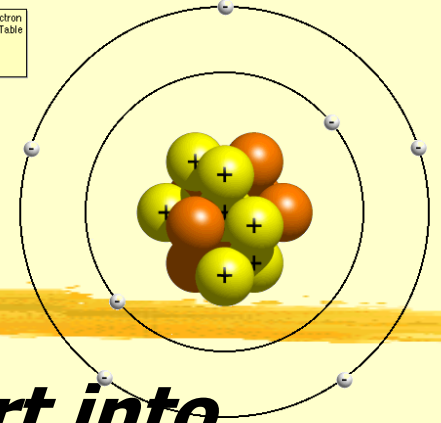
Why use “Bioremediation?” How does this help the environment?

- *What is ‘bioremediation?’*
- *Why can artificial fertilizers be bad to the environment?*
- *Why do farmers use holding ponds? How can these be harmful to the environment?*
- *How does bioremediation in this situation help farmers?*



The Elements

Nitrogen's Electron
Configuration Table
 $1s^2$
 $2s^2 2p^3$



- ***Fundamental forms of matter***
- ***Cannot normally be broken apart into another substance.***
- ***What are the building blocks of elements?***
- ***92 occur on Earth naturally***
- ***In all living things, the most abundant elements are oxygen, hydrogen, carbon, and nitrogen***
- ***What are the building blocks of elements?***

Elements Common in Living Things

EARTH'S CRUST		HUMAN		PUMPKIN	
Oxygen	46.6	Oxygen	65	Oxygen	85
Silicon	27.7	Carbon	18	Hydrogen	10.7
Aluminum	8.1	Hydrogen	10	Carbon	3.3
Iron	5.0	Nitrogen	3	Potassium	0.34
Calcium	3.6	Calcium	2	Nitrogen	0.16
Sodium	2.8	Phosphorus	1.1	Phosphorus	0.05
Potassium	2.6	Potassium	0.35	Calcium	0.02
Magnesium	2.1	Sulfur	0.25	Magnesium	0.01
Other elements:	1.5	Sodium	0.15	Iron	0.008
		Chlorine	0.15	Sodium	0.001
		Magnesium	0.05	Zinc	0.0002
		Iron	0.004	Copper	0.0001
		Iodine	0.0004	Other:	0.00005



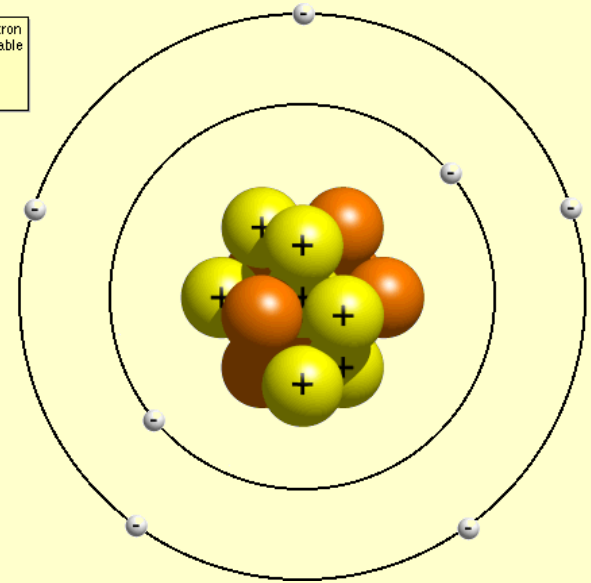
How are these proportions similar? How do they differ?

Which element has the greatest weight in the human body?

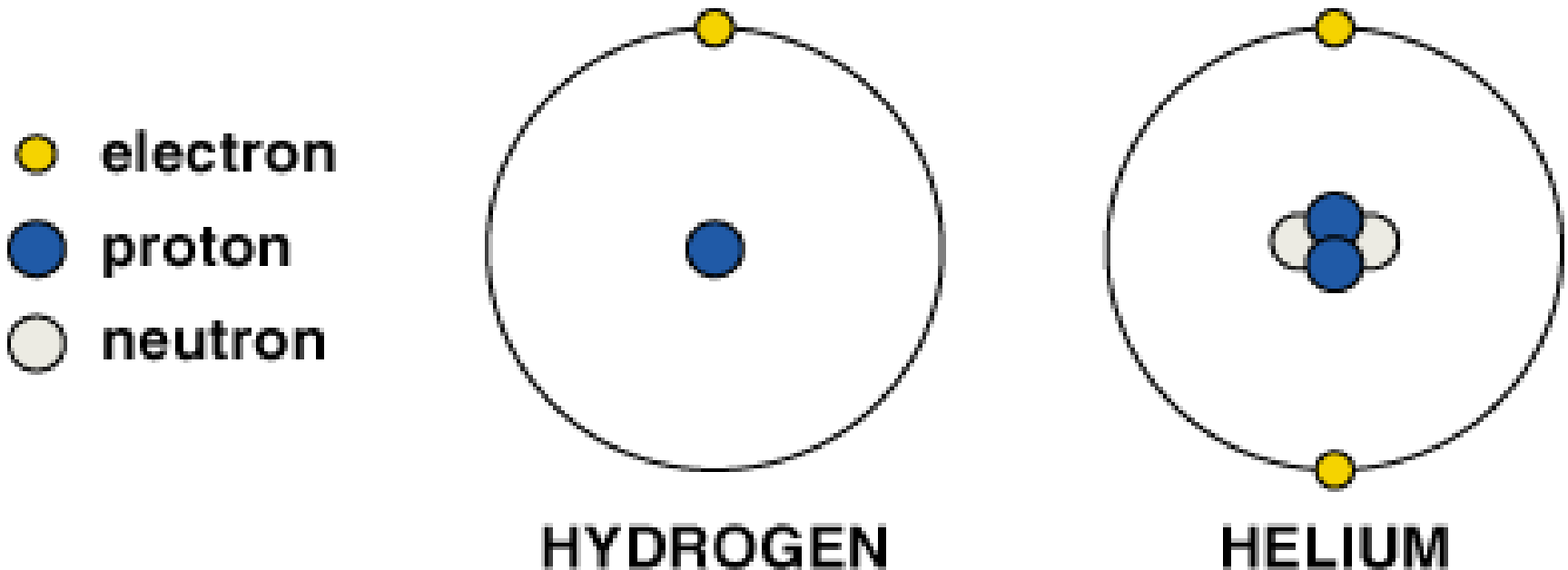
Structure of Atoms

- ***Subatomic particles:*** *Where are these particles located; mass, responsibility?*
 - ***Protons - positive charge***
 - ***Electrons - negative charge***
 - ***Neutrons - no charge***
- ***Atomic Number***
 - ***Number of protons***
- ***Mass Number***
 - ***Number of protons + number of neutrons***

Nitrogen's Electron
Configuration Table
 $1s^2$
 $2s^2 2p^3$



Model of Atomic Structure



Atomic Quiz

1. *What is the name of this element?*
2. *Is this element chemically stable?*
3. *How will this element most likely bond with another element?*
4. *How many protons does this element have? Why?*
5. *If the atomic weight of this element is 35 amu's, how many neutrons does this element have?*
6. *What is the chemical formula for calcium chloride?*



Periodic Table of Elements

- *What does the #17 represent?*
- *What subatomic particle(s) can be determined from the #17?*
- *How are elements listed on the periodic table?*
- *What group is this element placed in on the Periodic Table? What does the group number represent?*
- *What period is this element placed in? What does the period number represent?*
- *How many neutrons does this element have? What do we call elements that vary in the number of neutrons they have?*

Chlorine	
17	
Cl	
35.453	

Are there periodic trends in the Periodic Table? What are they?

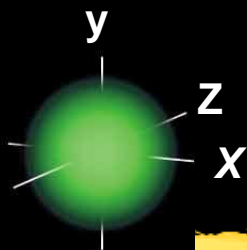
Element	Symbol	Atomic Number*	Distribution of Electrons			
			First Shell	Second Shell	Third Shell	Fourth Shell
Hydrogen	H	1	1	—	—	—
Helium	He	2	2	—	—	—
Carbon	C	6	2	4	—	—
Nitrogen	N	7	2	5	—	—
Oxygen	O	8	2	6	—	—
Neon	Ne	10	2	8	—	—
Sodium	Na	11	2	8	1	—
Magnesium	Mg	12	2	8	2	—
Phosphorus	P	15	2	8	5	—
Sulfur	S	16	2	8	6	—
Chlorine	Cl	17	2	8	7	—
Calcium	Ca	20	2	8	8	2

* The number of protons in the nucleus.

Electrons and Energy Levels

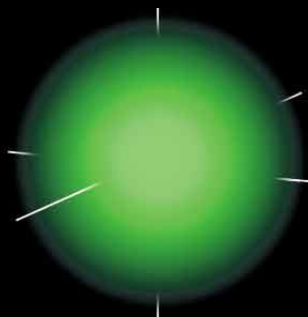
- ***Orbitals***
 - ***"Volumes of space"***
 - ***Spherical *s****
 - ***Dumbbell-shaped *p****
 - ***Specific number of electrons in an orbital***
 - ***2, 8, 18, 32, 32, 18, 8 Note: The maximum number of electrons an atom can hold in its outer shell is 8 (octet rule) except for the 1st orbital***

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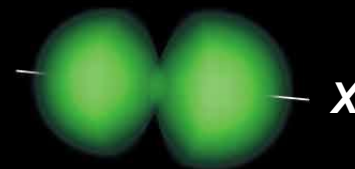
1s orbital

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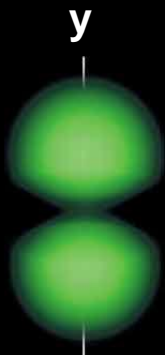
2s orbital

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2pxy orbital

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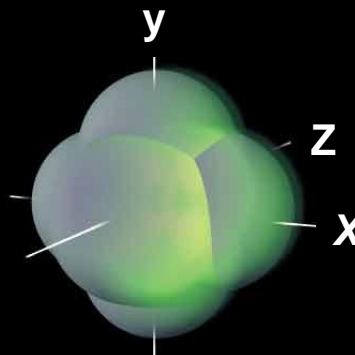
2 py orbital

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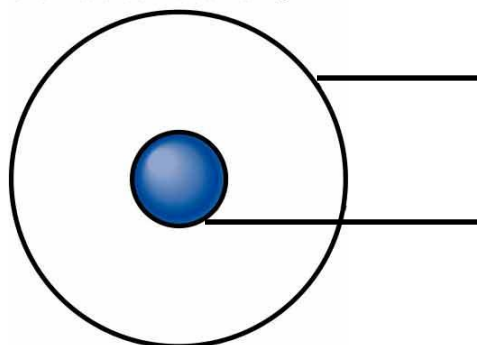
2 pz orbital

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When all p orbitals are full

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electron
orbital

atomic
nucleus

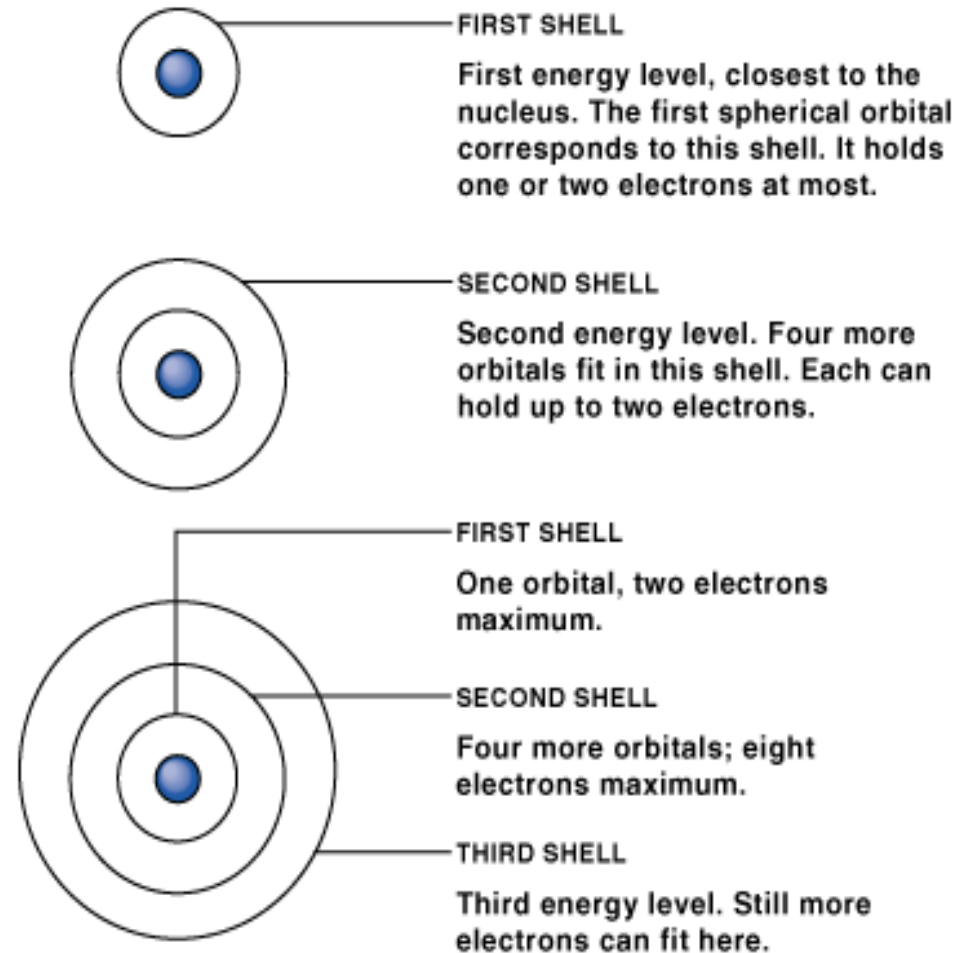
Hydrogen atom

- **Shells = Energy levels**

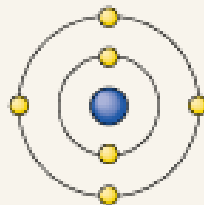
Electrons and Energy Levels

⌘ Shell model

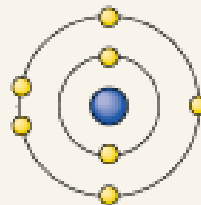
☐ Shell closest to nucleus has the lowest energy level



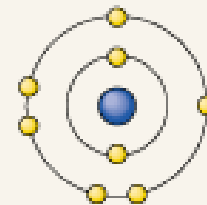
Shell Model of Distribution of Electrons in Atoms



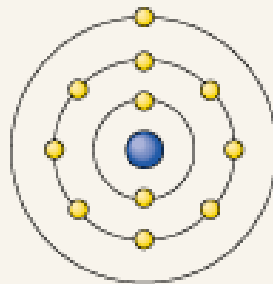
CARBON
 $6 p^+, 6 e^-$



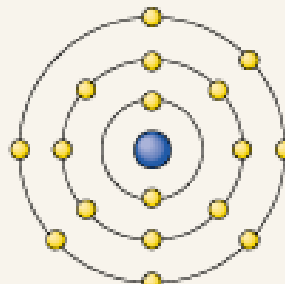
NITROGEN
 $7 p^+, 7 e^-$



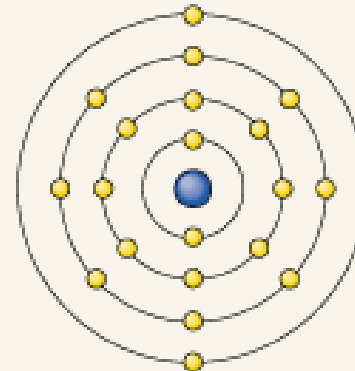
OXYGEN
 $8 p^+, 8 e^-$



SODIUM
 $11 p^+, 11 e^-$



CHLORINE
 $17 p^+, 17 e^-$



CALCIUM
 $20 p^+, 20 e^-$

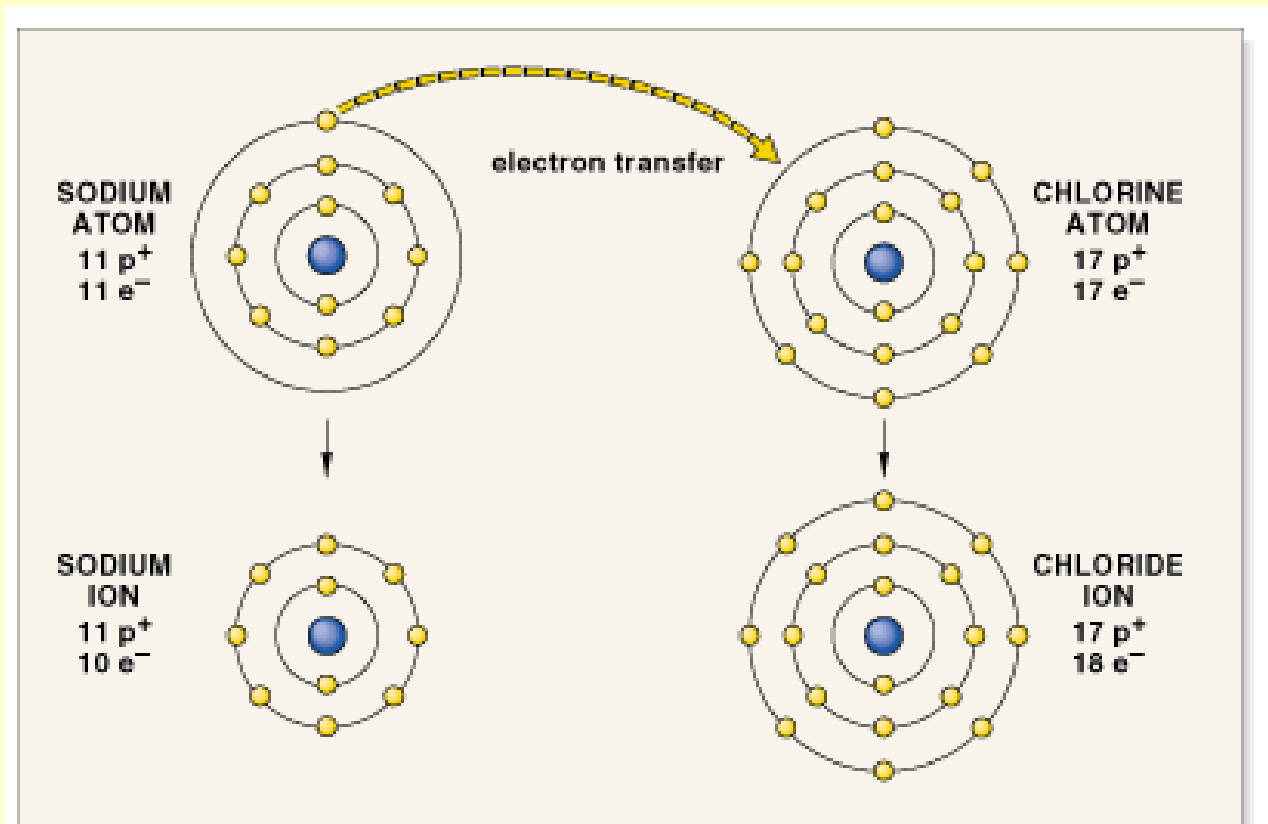
From Atoms to Molecules



- ***Molecule (molecules make up?)***
 - ***Two or more atoms bond***
- ***Compound***
 - ***Composed of two or more different elements in definite proportions***
- ***Mixture***
 - ***Two or more elements intermingling in varying proportions***

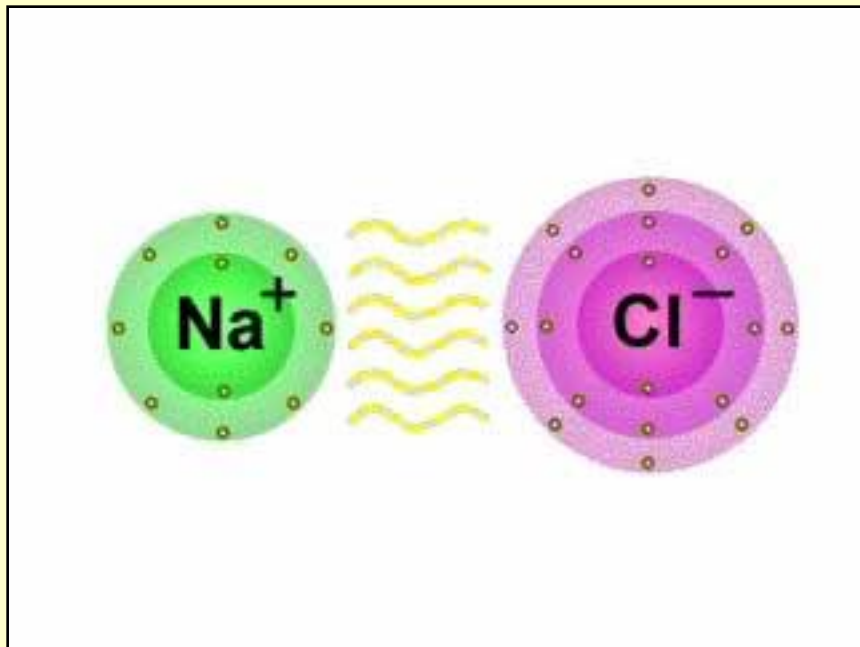
What are Ions?

- ***Any atom that has either gained or lost an electron***
- ***Charged***
- ***+ or -***



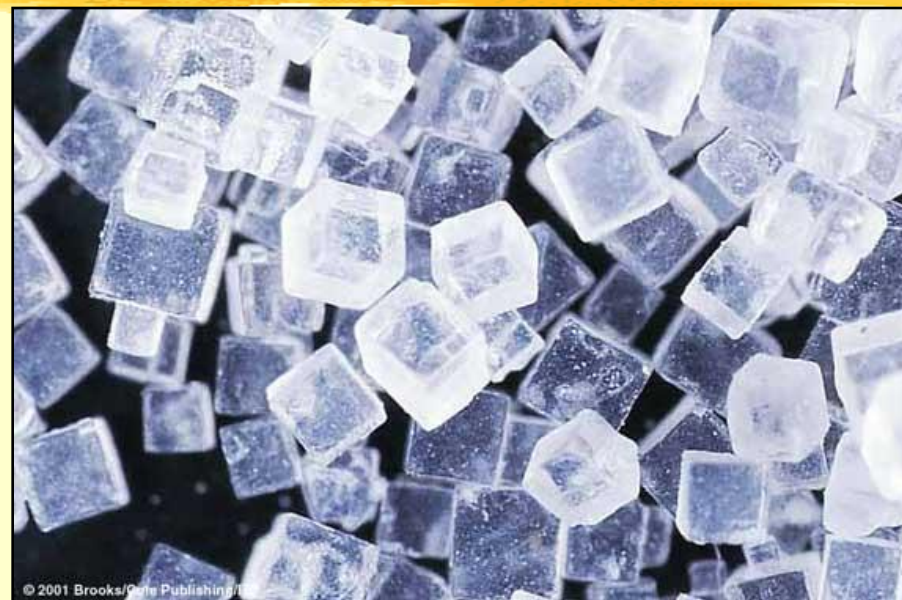
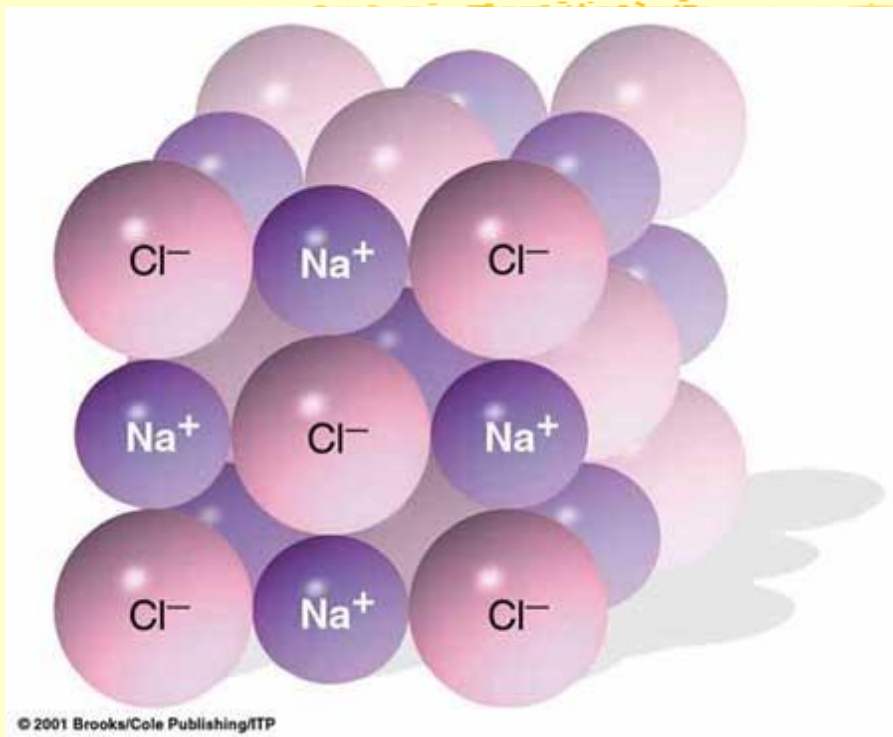
• See next slide

Ionic Bonding of Elements



[Click to view
animation.
ionic_bond.mov](#)

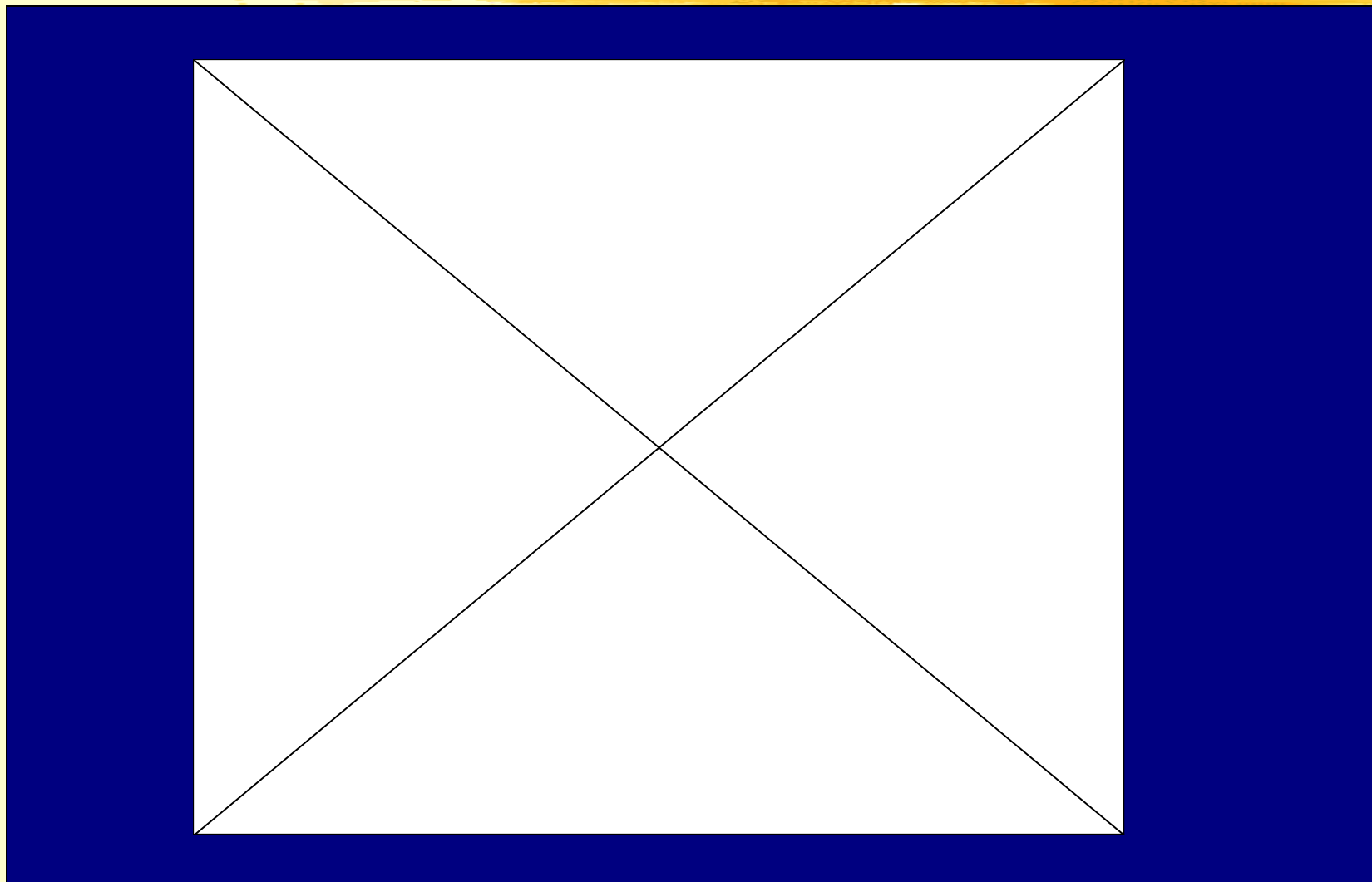
- *How does the electron configuration of sodium (Na) and chlorine (Cl) compare?*
- *What caused these atoms to become ionized?*
- *What will now happen to these atoms?*



1 mm

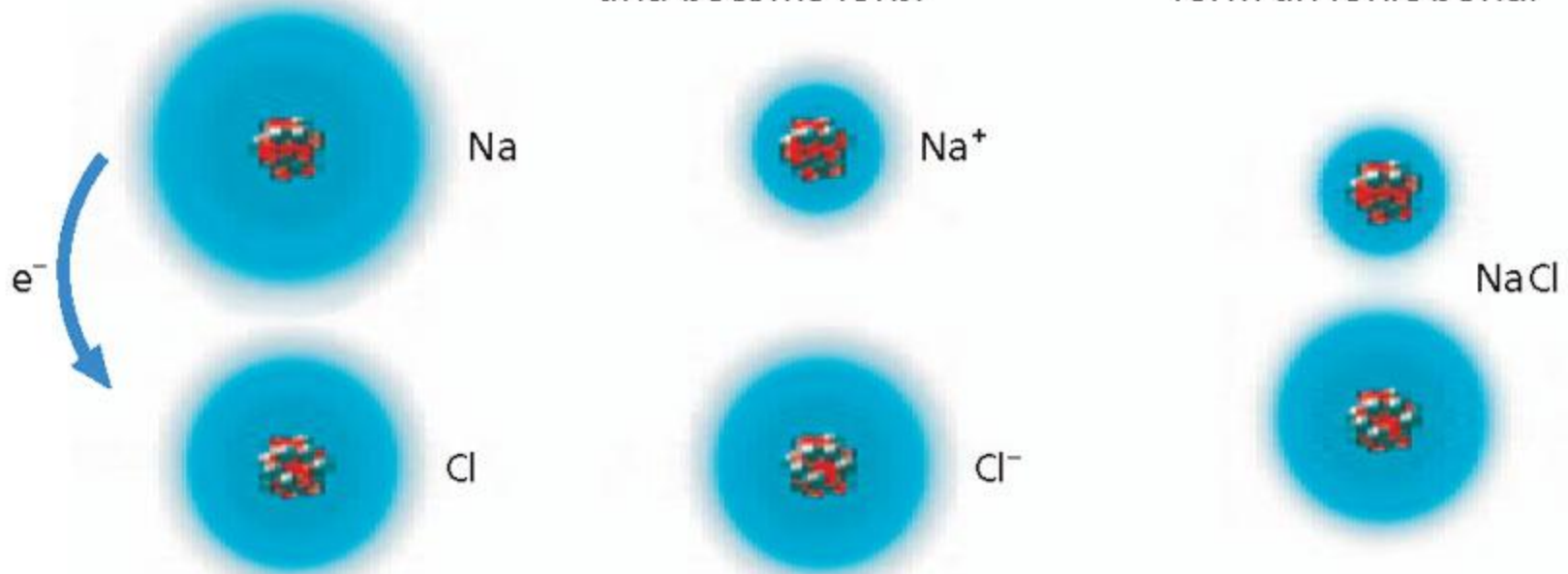
Fig. 2.10b, p. 26

Compounds

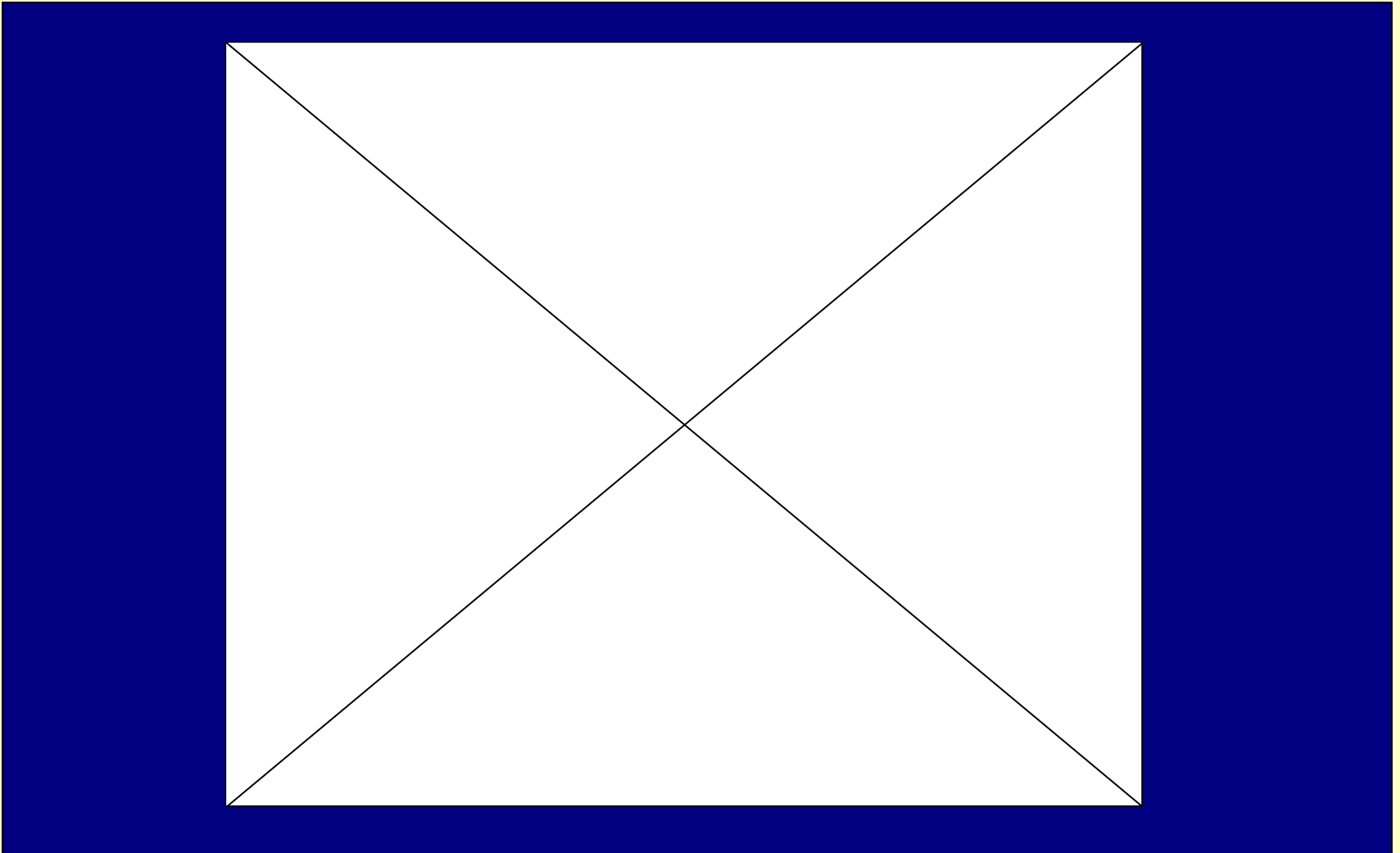


Ionic Bonding

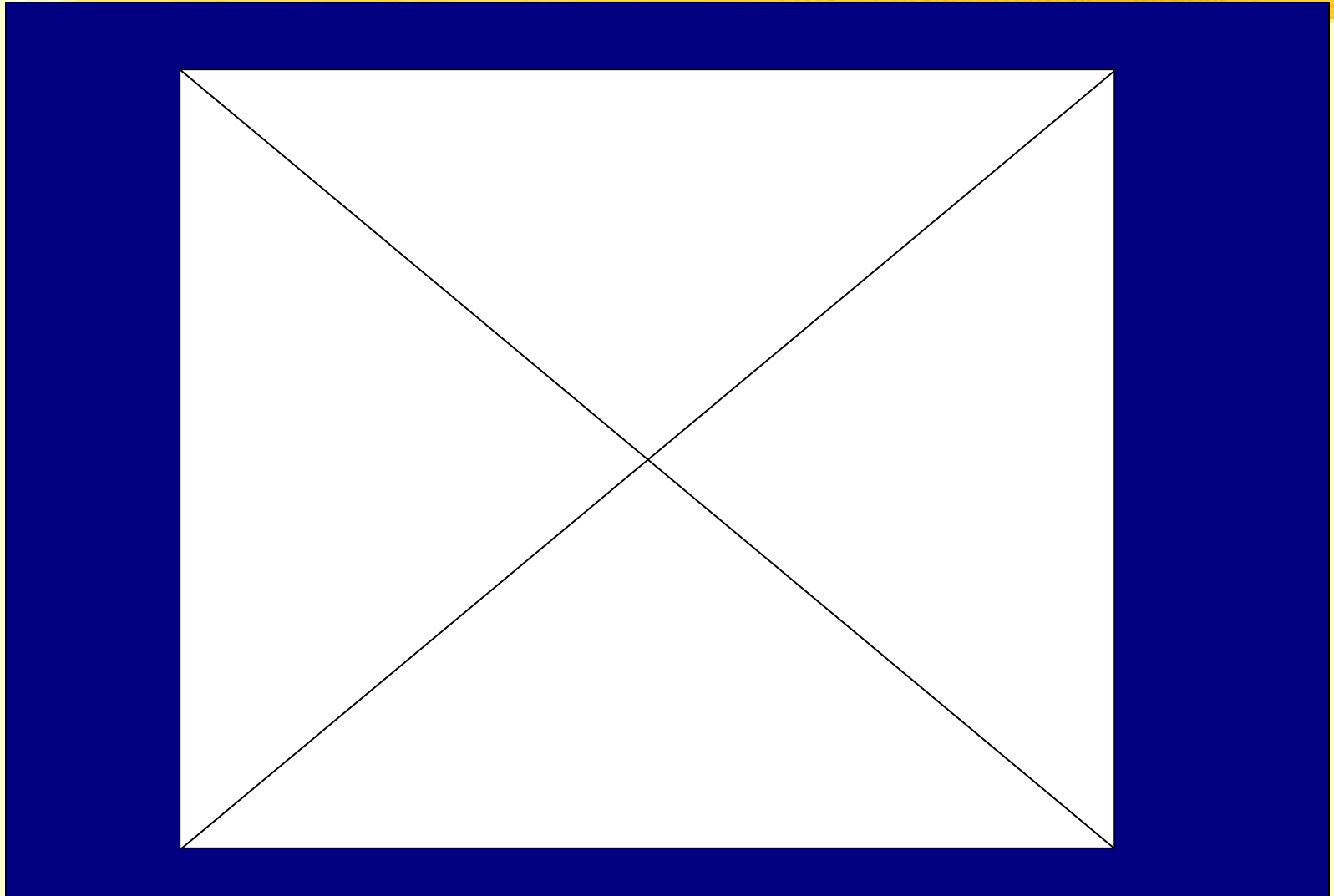
- 1 A Na atom loses an electron to a Cl atom.
- 2 Both atoms are now stable, but carry a charge and become ions.
- 3 The ions are attracted to one another to form an ionic bond.



Ionic Bonding



Covalent Bonding



Isotopes

- *Atoms of an element with different numbers of neutrons*
- *All isotopes interact with other atoms in the same way*
- *A radioisotope has an unstable nucleus that stabilizes itself by emitting energy and subatomic particles*
- *Radioactive decay transforms a radioisotope into a different element*

Isotopes of Hydrogen



[Click to view animation.](#)

- *How do we calculate the number of neutrons in an atom?*
- *What is atomic weight? How is it calculated?*
- *Calculate the number of p^+ , e^- , neutrons in a Lithium atom.*

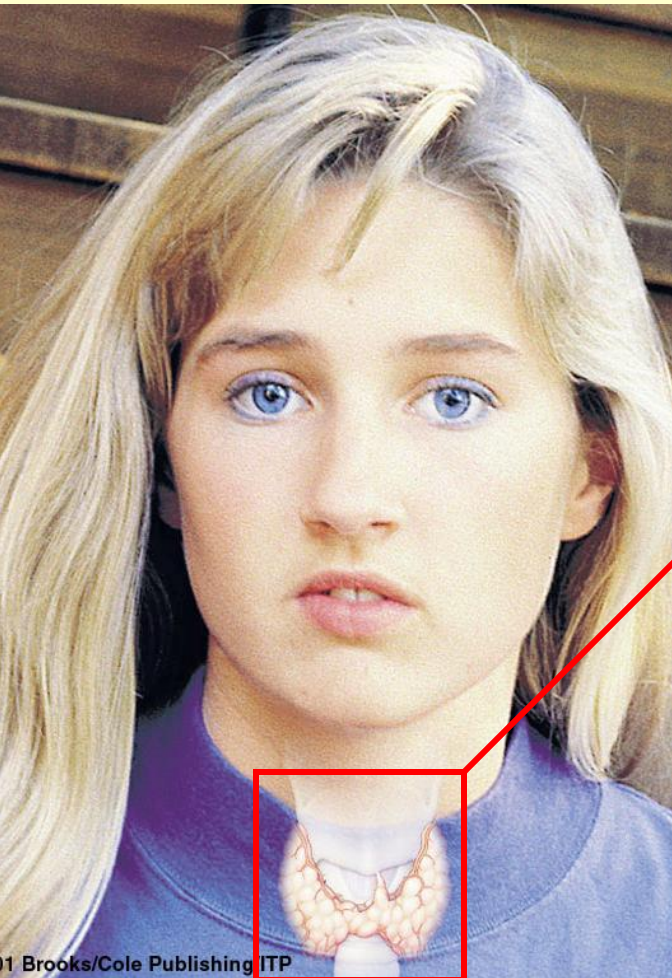
Radioactive Tracer



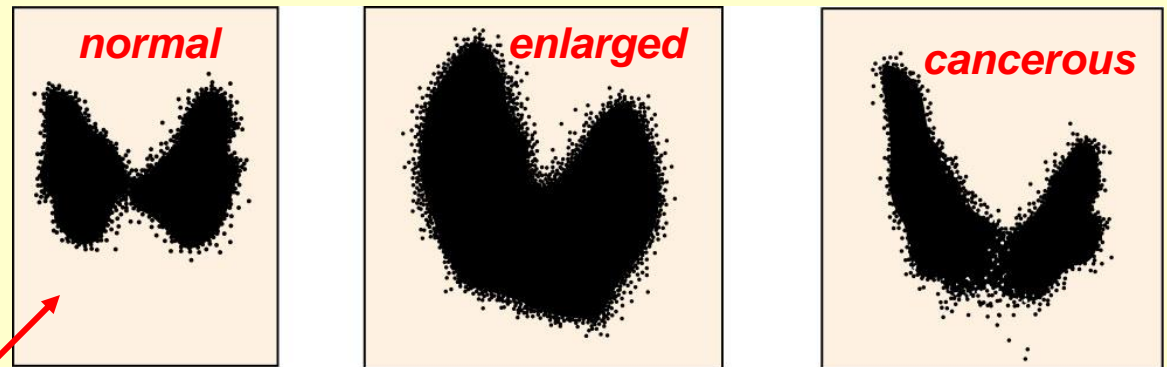
- *A substance with a radioisotope attached to it that researchers can track after they deliver it into a cell, body, ecosystem, or some other system*
 - *Examples*
 - *Thyroid scan*
 - *PET Scan*
- How does your body treat a radioisotope?*

PROBLEM

*A person has demonstrated poor growth & metabolism,
what can be done?*



•What structure is responsible for persons growth and metabolism?



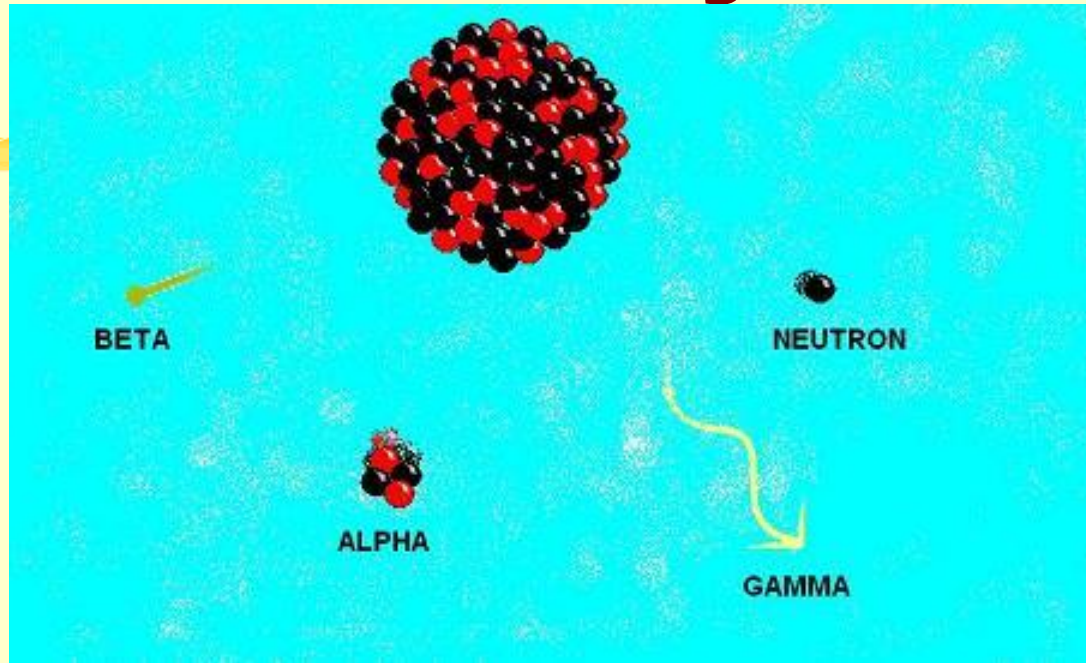
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•How can doctors target the thyroid glands for treatment?

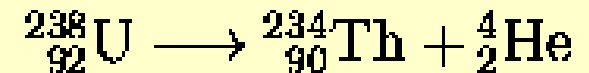
•Using trace elements can be tracked to follow biochemical reactions.

•What is Chernobyl and why is it important?

Radioactive Decay of Elements



- *Unstable atoms (nucleus) decay (nucleus loses particles), giving off energy causing the atom to transmute (change) into another element.*
- *These are often called radioisotopes.*
- *What does Uranium – 238 transmute into when an Alpha particle is emitted? Why?*



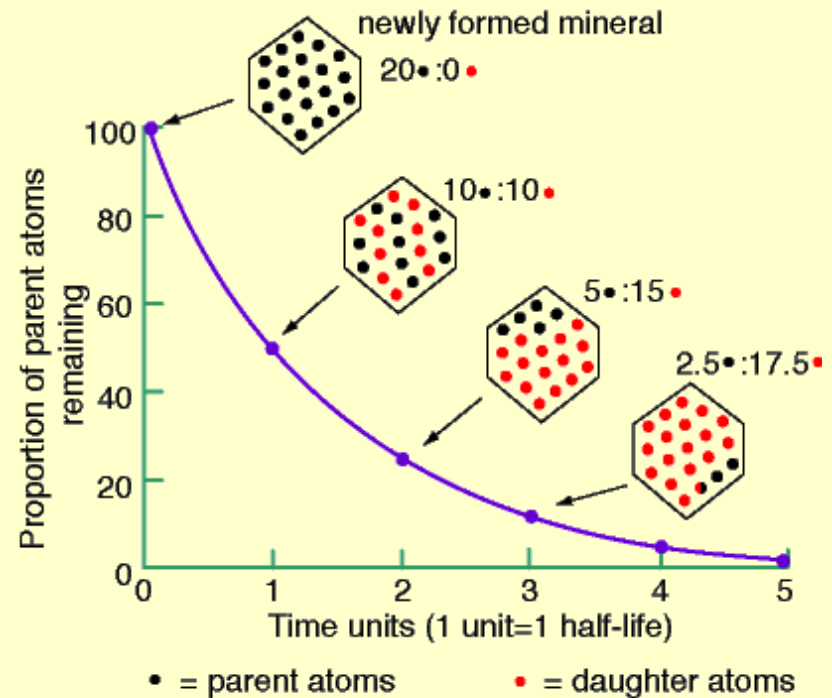
The Half-life of a Radioactive Element

•What is the definition of half life?

ANS: The time required for half the atoms of a radioisotope to transmutate into another element.

•Problem: The half-life of carbon-14 is 5730 yrs (+ or – 40). How many years must pass for a substance to go through 6 half-lives?

•Problem: A mammoth should have $\frac{1}{4}$ of a gram of carbon-14 in its body when alive. If there is only $\frac{1}{64}^{\text{th}}$ of a gram in the fossilized bones of this mammoth, then how old is this fossil?



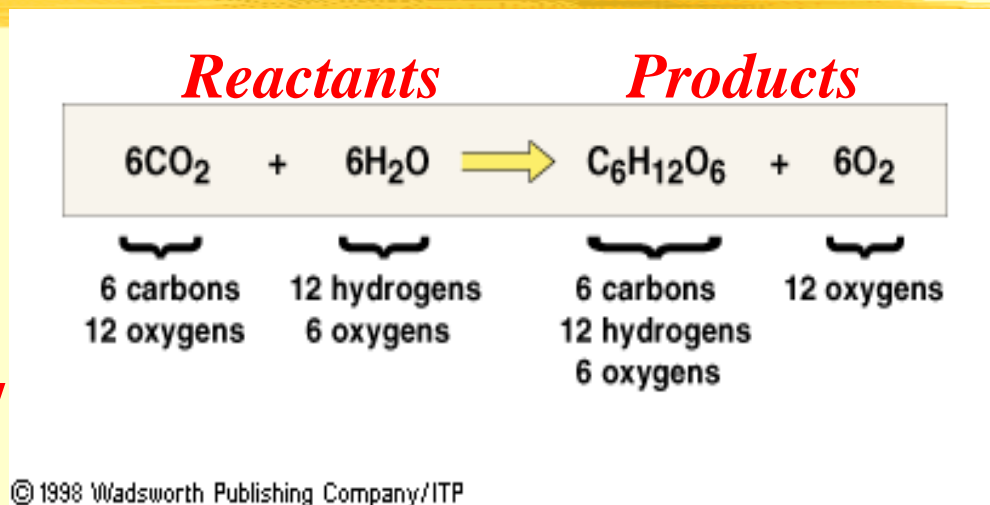
How does carbon-14 accumulate into an organism?

When Atoms Bond in a Chemical Reaction

- ***Chemical bonds***
 - ***What are chemical Formulas ?***

They represent the kinds and number of atoms in a compound
- ***What are reactants and products in a chemical equation?***

Reactants produce products



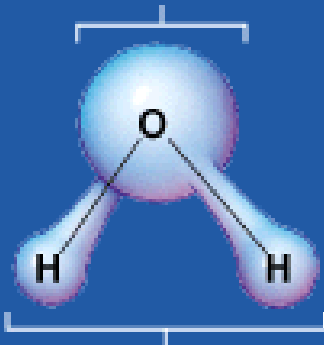
What is the molecular weight of glucose?

180

Important Bonds in Biological Molecules

- ***Ionic Bonding (sodium chloride; salt)***
- ***Covalent bonds***
 - ***Sharing of a pair of electrons***
 - ***Single, Double, and Triple Bonds***
 - ***Non-polar or polar***
 - ***Polar - atoms of different elements don't exert same pull on shared electrons***
 - ***Non-polar – electrons shared equally.***

slight negative charge at this end



slight positive charge at this end

but the whole molecule has no net charge (+ and – balance each other)

Question: Can you have electrons shared in the following bonding examples? (covalent, polar, and non-polar)

YES TO ALL OF THESE

Single Covalent Bonding

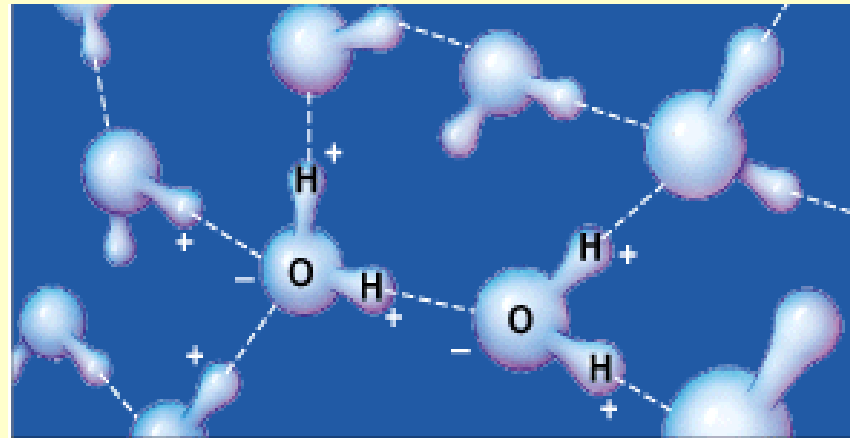
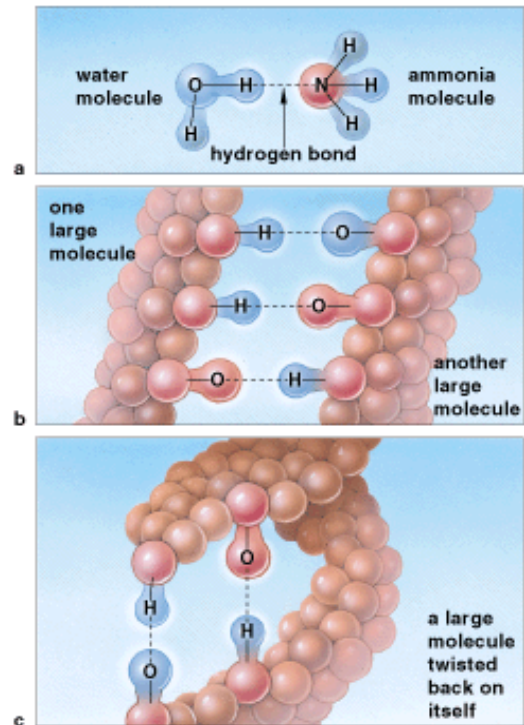


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Important Bonds in Biological Molecules

- ***Hydrogen bonds***

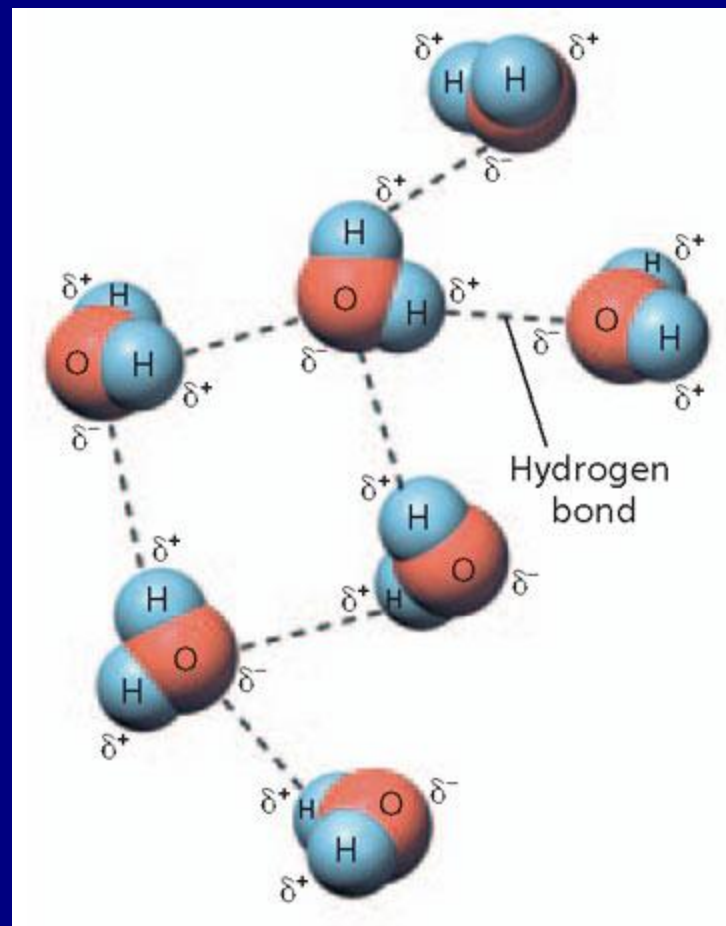
- ***The attraction of 2 or more large molecules due to the charge of the hydrogen atoms.***
- ***Electronegative atom of a molecule weakly interacts with another charged molecule.***



Hydrogen bonds may form between two or more molecules creating very large molecules.

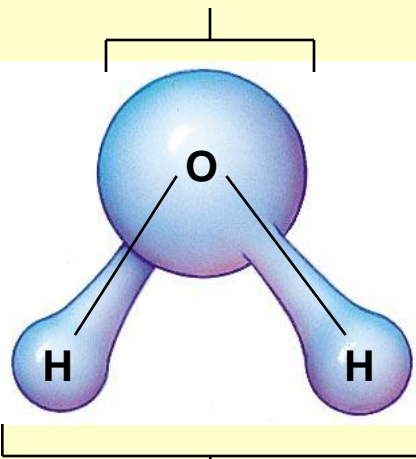
Hydrogen Bonding

- A **hydrogen bond** is the force of attraction between a hydrogen molecule with a partial positive charge and another atom or molecule with a partial or full negative charge.



slight negative charge at this end

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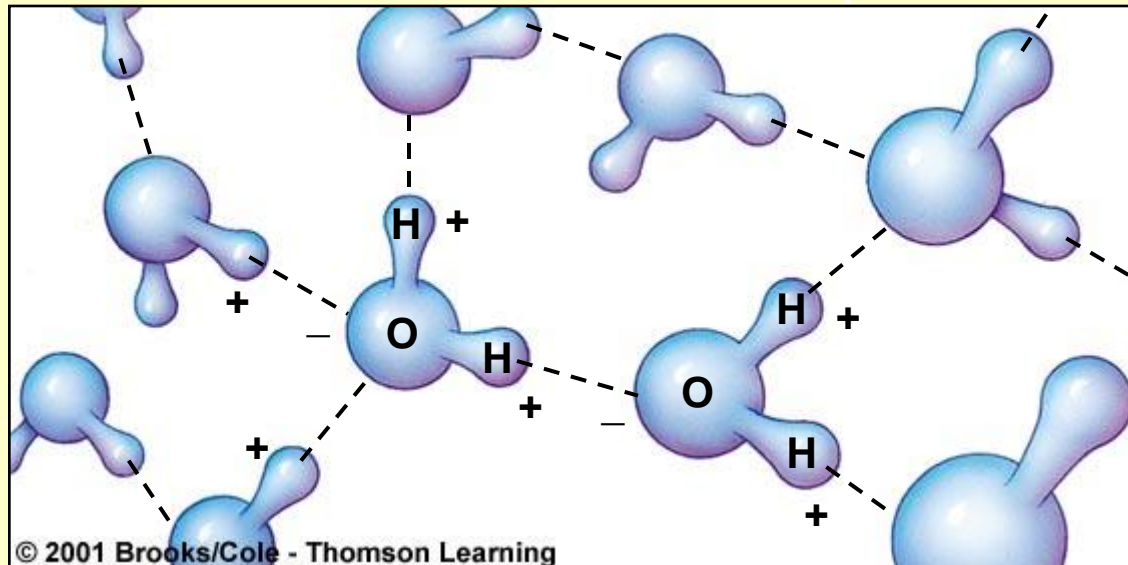


slight positive charge at this end

but the whole
molecule has
no net charge
(+ and - balance
each other)



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Fig. 2.13, p. 28



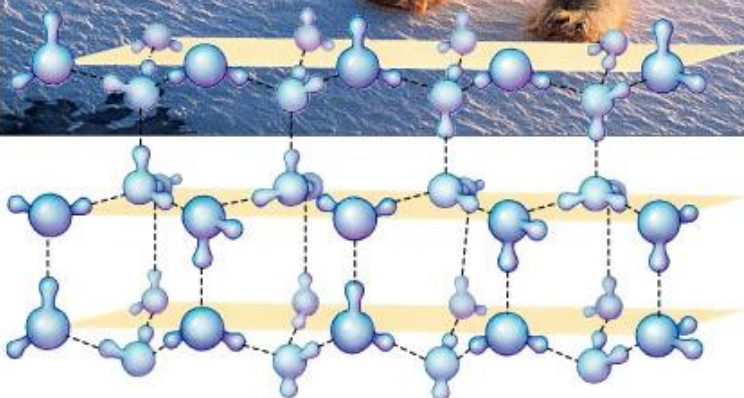
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Question: What do you notice about the positioning of the water molecules in ice?

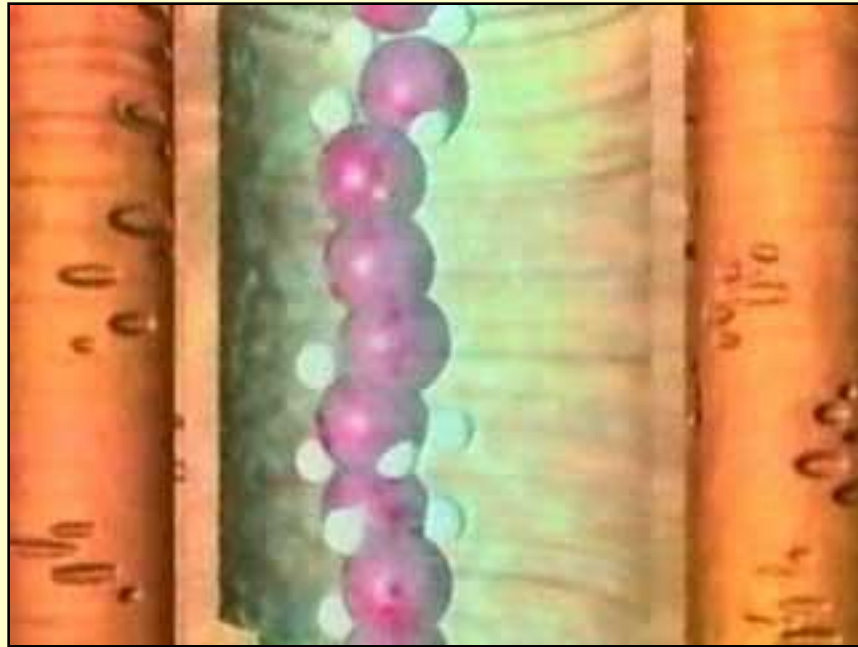
The water molecules are locked into position giving them a geometric pattern.

Question: Is ice more dense or less dense than liquid water? Why

In ice water molecules are positioned further apart than in liquid water.



How does water get to the leaves of trees hundreds of feet tall?



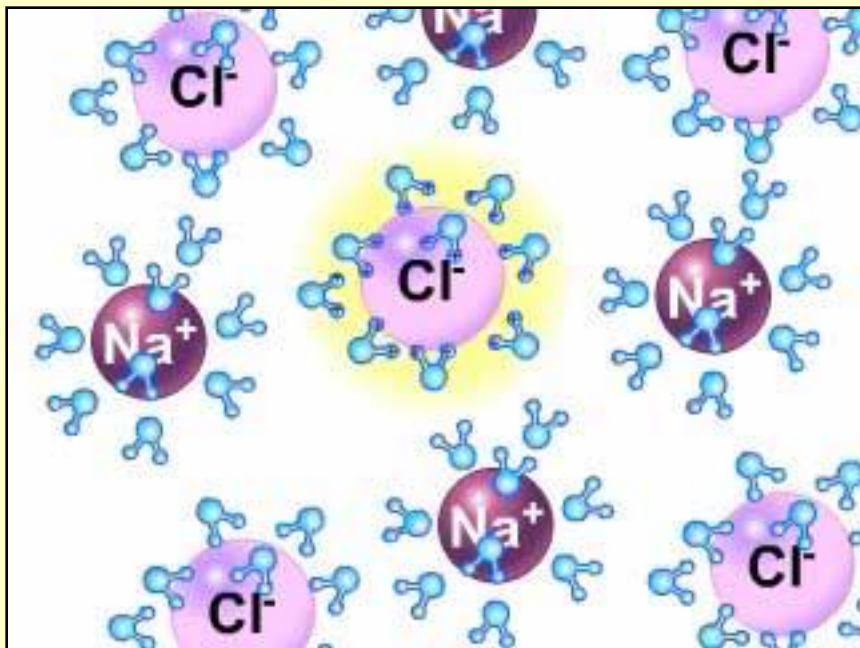
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animation

Properties of Water



- ***Polarity***
 - ***Hydrophilic***
 - ***Repels hydrophobic substances***
- ***Temperature***
 - ***Stable environments***
 - ***Evaporation***
 - ***Insulating***
- ***Cohesion***
 - ***High surface tension***
- ***Solvent***
 - ***Ions and polar substances***

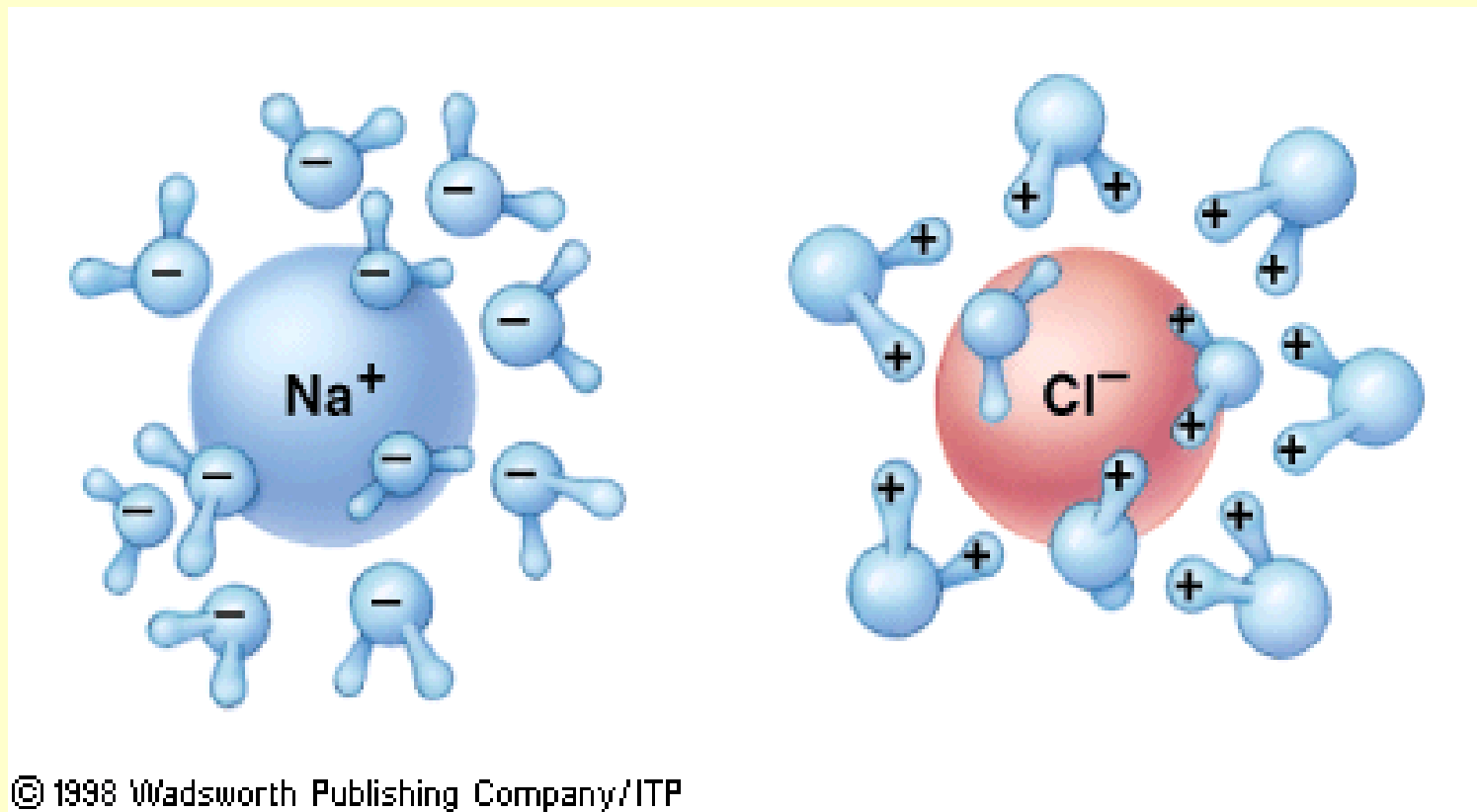


*Why does salt dissolve
in water and not in
alcohol?*

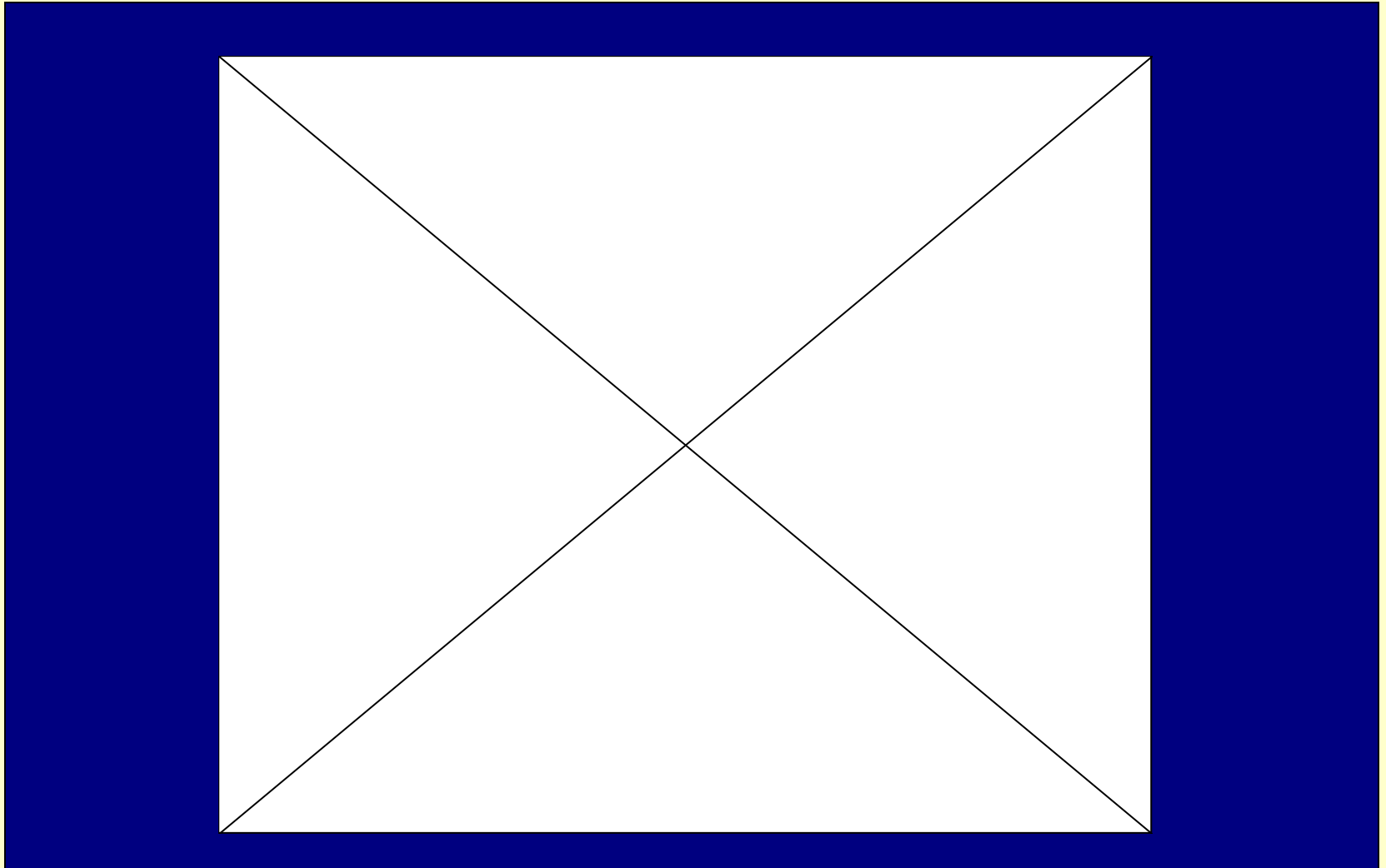
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Spheres of Hydration Around Two Charged Ions

- ⌘ Salt (NaCl) dissolves in water and separates into Na^+ and Cl^-

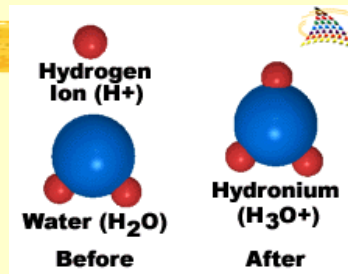


Comparing Cohesion and Adhesion

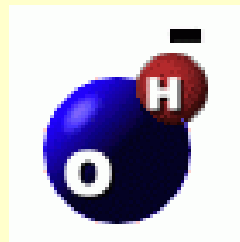


Classifying Solutions; Acid or Base

- ***Water molecules can be broken apart to form H^+ and OH^- ions***

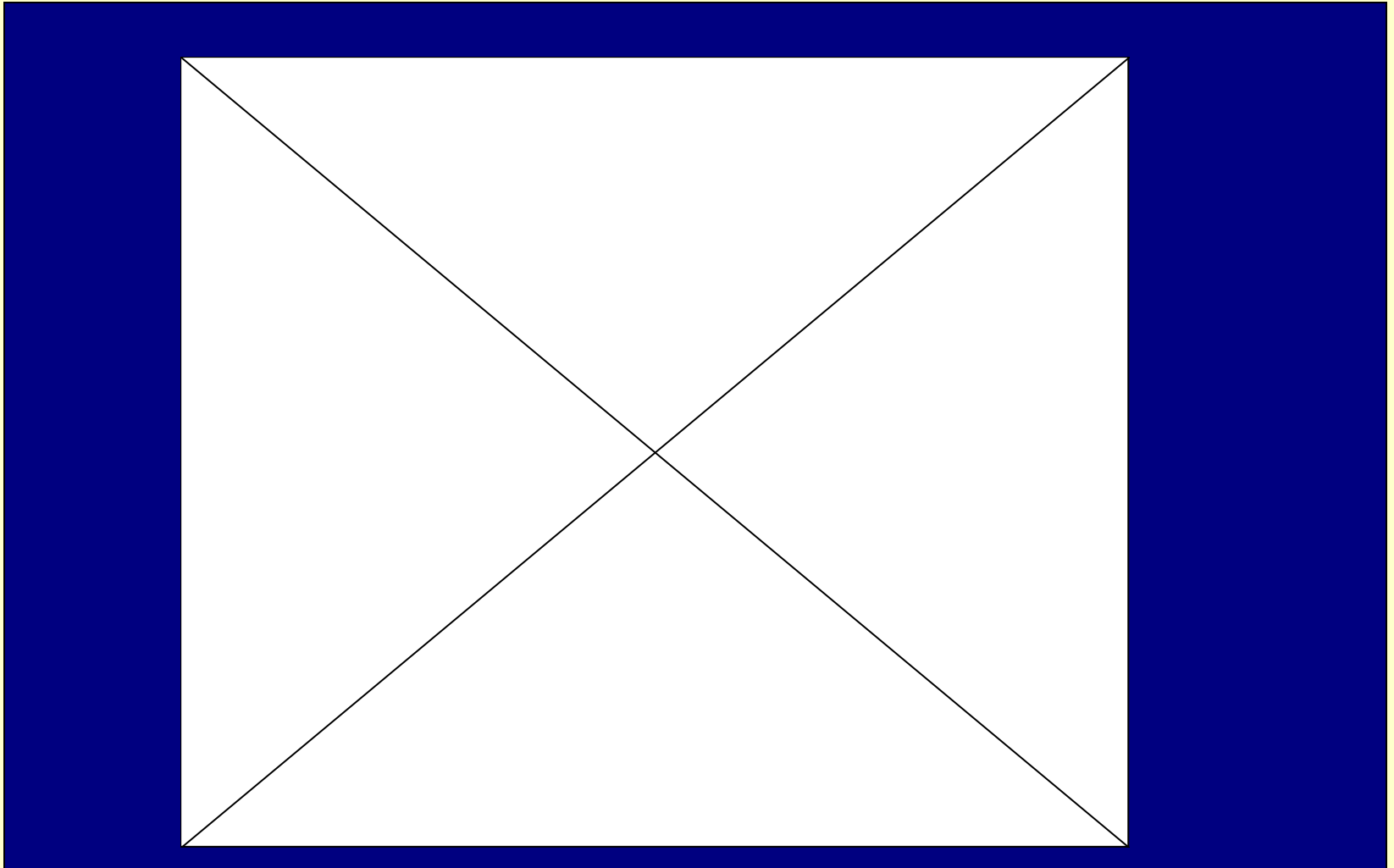


- ***Acid:***
 - ***substance that donates H^+ ions***
 - ***If a solution has a greater amount of hydronium ions than hydroxide ions.***

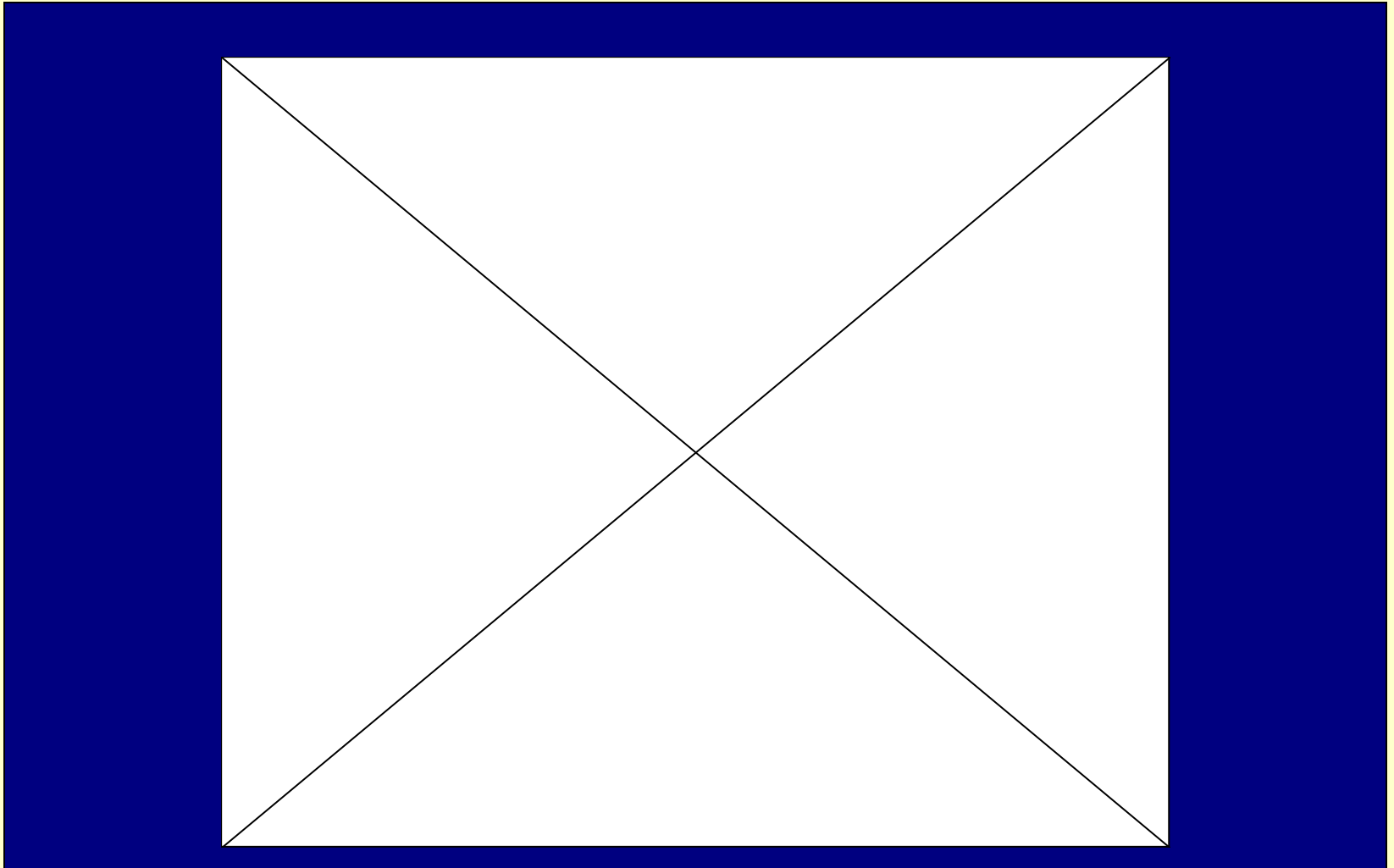


- ***Base:***
 - ***substance that accepts H^+***
 - ***If a solution has greater number of hydroxide ions than hydronium ions***
- ***Scale : 0 - 14***
 - ***Neutral: 7***
 - ***Acid: 0 to less than 7***
 - ***Base: greater than 7 to 14***

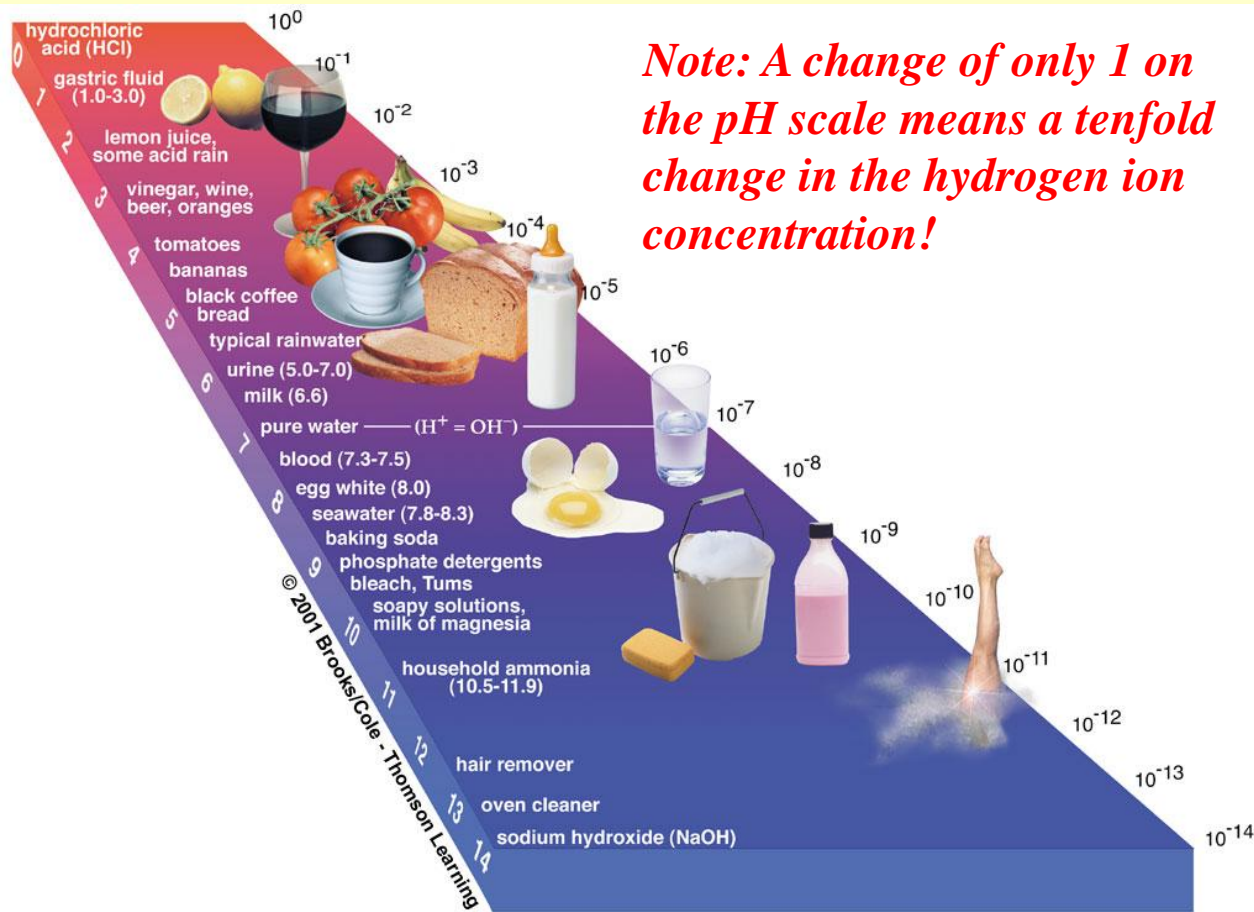
Bases



A Solutions pH

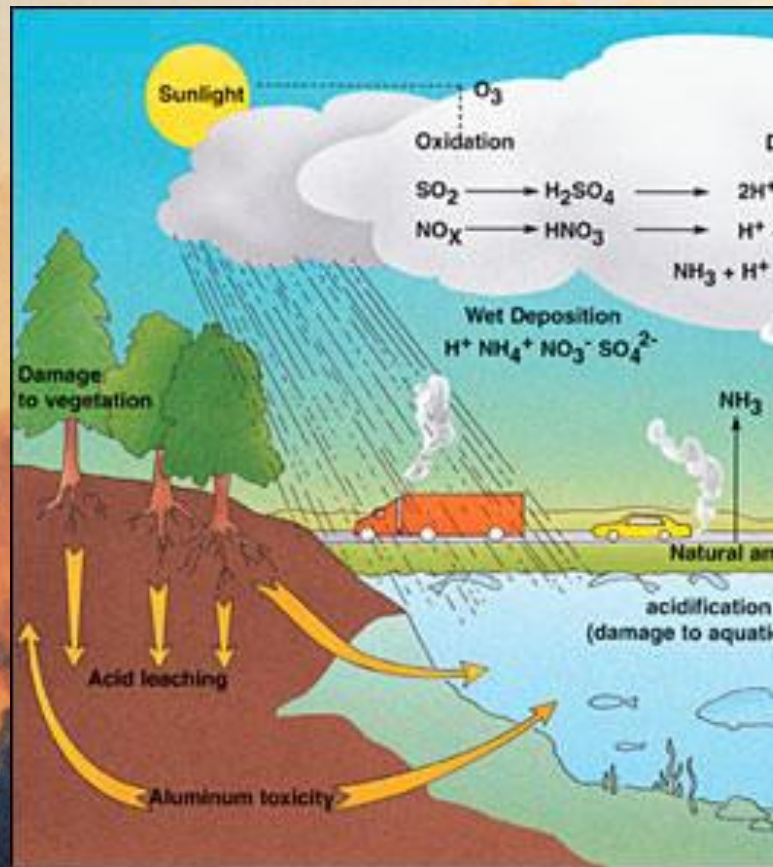


A closer look at the pH scale

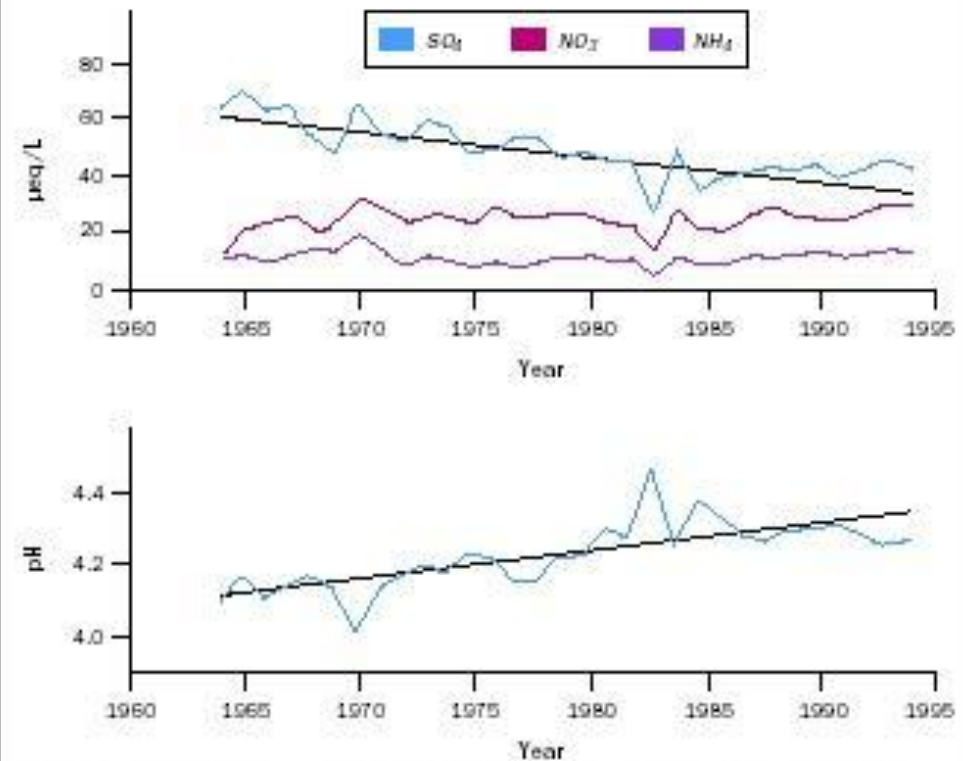


Question: If you ate 3 oranges, what would happen to your pH? What could you eat to neutralize your pH?

How does this pollution harm the environment?



LONG-TERM TRENDS IN SULFATE, NITRATE, AND AMMONIUM CONCENTRATIONS AND pH IN WET DEPOSITION AT THE HBEF, 1963-1994



SOURCE: Driscoll, C. T.; G. B. Lawrence; A. J. Bulger; T. J. Butler; C. S. Cronan; C. Eger; K. F. Lambert; G. E. Likens; J. L. Stoddard; and W. C. Weathers. (2001). *Acid Rain Revisited: Advances in Scientific Understanding since the Passage of the 1970 Clean Air Act Amendments*. Hubbard Brook Research Foundation. Science Links™ Publication, Vol. 1, No. 1.

Buffers Against Shifts in pH

- ***Buffer systems***
 - ***Stabilize and maintain pH***
 - ***Bicarbonate-carbonic acid buffer system:***
 - ***$H_2CO_3 \rightleftharpoons HCO_3^- + H^+$***
 - ***$HCO_3^- + H^+ \rightleftharpoons H_2CO_3$***
 - ***Question: What is the difference between regular and buffered aspirin?***
- ***Salts: Compounds that release ions other than H^+ and OH^-***



[Click to view
animation.](#)

animation